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EXAMINER	
KIELIN, ERIK J	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 06/10/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/388,826	LI ET AL.	
	Examiner	Art Unit	
	Erik Kielin	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *03 May 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *102-124,126-131 and 133-139* is/are pending in the application.

4a) Of the above claim(s) *113,114 and 135-139* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *102-112,115-124,126-131,133 and 134* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *5-3-2004*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 3 May 2004 has been entered.

Election/Restrictions

2. Applicant's arguments traversing the restriction by original presentation are noted. Examiner respectfully disagrees on all counts of the argument.

First it is noted that Applicant has switched inventions several times. The first examined invention was drawn to depositing --by any deposition method-- a $(CH_3)_XSiO_Y$ layer and then reducing the dielectric constant of the $(CH_3)_XSiO_Y$ layer WITHOUT CONVERTING the base chemistry of the $(CH_3)_XSiO_Y$ layer using an oxygen plasma. (See paper filed **2 May 2001**.) Then Applicant shifted inventions, canceling all of claims 1-65 and introducing a new set of claims 66-101 drawn to CVD depositing any silicon-carbon dielectric layer and then COMPLETELY CONVERTING the silicon-carbon dielectric to a silicon-carbon-oxygen dielectric using an oxygen plasma. So the invention was changed from a method of reducing a dielectric constant to a method of depositing a silicon-carbon-oxygen dielectric. Then in the paper filed **5 May 2002**, Applicant yet again switched inventions, canceling claims 66-101 and introducing new claims 102-134. New claims 102-134 are drawn to the combination of CVD depositing a dielectric

layer, plasma **converting** the CVD-deposited layer to a new base chemistry with a lower dielectric constant by oxygen plasma treatment. **Presently** the claims are drawn to yet another **alternative embodiment**, including the combination of CVD depositing a dielectric layer, plasma **converting** the CVD-deposited dielectric layer to a new base chemistry using an oxygen plasma, and then plasma treating **without** converting the base chemistry of the dielectric layer using a different oxygen plasma.

Examiner accepted the burden of examination of all of these different groups of inventions. Examiner respectfully submits that Examiner has been more than gracious in allowing Applicant to switch inventions **four** times thus far. In the Paper filed **16 September 2003** Applicant introduces yet **another** invention by submitting new claims 113, 114 and 135-139 drawn to depositing a dielectric layer of **unspecified composition** and then reducing the dielectric constant of the unspecified dielectric layer using a plasma, the claims **drawn solely to the plasma parameters**.

Examiner respectfully submits that it generates undue burden to now search and examine --**in addition to** the ongoing examination of the presently selected inventions already being searched, the third switch in inventions-- **yet another invention** drawn to ANY DIELECTRIC MATERIAL given specific plasma deposition parameters. Not only is this invention is not enabled in scope with the existing disclosure --because all dielectric materials cannot be reduced in dielectric constant by exposure to oxygen plasma-- but it is extremely burdensome to now additionally look for all of the presently claimed plasma deposition parameters for deposition and separately reduction of the dielectric constant of **ALL** dielectric materials.

Finally it is noted that Applicant has failed to provide any statement that these new species are **obvious variants**. Accordingly, Examiner assumes that Applicant concurs that they are patentably distinct **from those species presently claimed** and would support their own patent.

The restriction requirement is deemed proper and is therefore made FINAL.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims **102**-112, 115-124, 126-128, and **129**-131, 133, 134 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claims **102**-112, 115-124, 126-128, and **129**-131, 133, 134 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

Regarding independent claims 102 and 129, the instant specification indicates that the blanket exposing to form the $(CH_3)_XSiO_Y$ layer from the non-descript first layer of Si bonded to

methyl groups without oxygen, is a separate step from the blanket exposing of the $(CH_3)_XSiO_Y$ layer to reduce its dielectric constant. As presently written, the claim requires the conversion to $(CH_3)_XSiO_Y$ and the reduction of its dielectric constant to happen simultaneously or with a single plasma oxygen exposure. There is no support in the specification for the conversion to $(CH_3)_XSiO_Y$ and reduction of the dielectric constant of $(CH_3)_XSiO_Y$ to occur with the same oxygen plasma exposure. Accordingly, this is not enabled and is new matter.

The specification proves that the plasma exposure to convert the non-descript "first layer" of methyl groups bonded to silicon atoms without oxygen to $(CH_3)_XSiO_Y$ is different from the oxygen plasma exposure used to reduce the dielectric constant. In the paragraph bridging pages 9 to 10, the oxygen exposure for converting the non-descript "first layer" to $(CH_3)_XSiO_Y$ is characterized as being performed by "plasma, heat or ultra-violet light" in the presence of some oxygen-containing moiety, for example O_2 or N_2O. No plasma is required and no plasma conditions are provided. By contrast, in the paragraph bridging pp. 11 and 12, the oxygen exposure to reduce the dielectric constant must specifically be a plasma. Nowhere in the specification is the plasma for reducing the dielectric constant characterized as being the same as that for converting the non-descript first layer into $(CH_3)_XSiO_Y$. This is new matter. This further makes non-elected claims 113 and 114, which add the dielectric constant-reducing plasma parameters as those used for the conversion step, not enabled, since these plasma parameters used for reducing the dielectric constant are **nowhere** indicated in the specification to be also used for the conversion step.

5. Claims **102**-112, 115-124,126-128 and **129**-131, 133, 134 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

The specification fails to enable one of ordinary skill how to "blanket expose the first layer to an oxygen comprising plasma... that allows the base chemistry of **the whole** deposited first layer to remain substantially without transformation to another base chemistry after the blanket exposing converts the first layer to the insulative layer." See instant specification, which states,

> "It is a preferred intent of the exposing to further **not transform a whole of all of the dielectric layer** from one base chemistry to another base chemistry by the exposing. An **outermost portion of the exposed layer might experience a slight reduction in carbon content**, but otherwise that portion and the whole of the layer is not transformed from one fundamental material to another even in spite of the low k reducing or resulting property." (Emphasis added; page 12, lines 3-9.)

Additionally, the claims extend beyond the scope of the instant specification by failing to indicate which portion of the first layer remains unchanged by the exposure. It is not some unspecified portion, but is specifically that portion other than the surface region that remains unchanged according to the specification. This is the only untransformed portion of the insulative layer for which the specification provides support.

In addition to the admission in the instant specification that the base chemistry is transformed, the following additional independent evidence is provided, for example, for $(CH_3)_xSiO_y$ to fail to remain substantially as $(CH_3)_xSiO_y$. The prior art to be presented below

clearly indicates that the oxygen plasma necessarily reacts with the methyl function, thereby breaking the bonds. See **Wang** et al. (US 6,028,015), **Morita** (JP 63-157443 A), or **Brinker** et al. (US 5,948,482) for verification; each, as indicated below, teaches that oxygen plasma necessarily removes a portion of the organic moiety from the dielectric layer.

Wang indicates that the oxygen plasma severs the Si-C bond of the $Si-CH_3$ moiety, stating

> "In particular, for example, when the surface of such a low dielectric constant **methyl silicon oxide** insulation layer is exposed to **oxidizing or "ashing" systems, which are used to remove a photoresist mask from the low dielectric constant methyl silicon oxide** insulation layer, after formation of openings therein, it has been found that the **ashing** process results in damage to the bonds **(severance) between the methyl radicals and the silicon atoms** adjacent the surfaces of the low dielectric constant methyl silicon oxide insulation layer exposed to such an ashing treatment. The term "openings", as used herein, is intended to describe either vias between two layers of metal interconnects or contact openings between devices on the substrate and a metal interconnect layer. **This severance of the carbon-silicon bonds, in turn, results in removal of such organic materials formerly bonded to the silicon atoms** along with the organic photoresist materials being removed from the integrated circuit structure. The **silicon atoms from which the methyl radicals have been severed**, and which are left in the damaged surface of the low dielectric constant methyl silicon oxide insulation layer, have dangling bonds which are very reactive and become water absorption sites if and when the damaged surface is exposed to moisture." (Emphasis added; column 1, line 52 to column 2, line 7.)

Wang indicates further in this regard,

> "...i.e., those silicon atoms **previously** bonded to organic radicals stripped from the silicon atoms by exposure to the **oxidizing/ashing treatment** used to remove resist mask 40. (Emphasis added; column 3, lines 50-52.)

Wang further indicates that the "oxidizing/ashing" means of removing the photoresist is **O_2 (oxygen) plasma**, as below:

> "The respective resist masks wo[u]ld then be removed from both wafers by a **standard ashing process** consisting of an **O_2 plasma**." (Emphasis added; column 5, lines 3-5.)

Similarly, the translation of **Morita** states,

> "When this semiconductor substrate 1 is exposed to an **oxygen plasma** for ten minutes, the **organic functional groups** of **organic** silicon thin film 10 **are removed** to a desired depth, transforming into a silicon oxide film." (Emphasis added; page 5 of translation, lines 5-9).

Similarly, Applicant admits that **Brinker** states,

> "Optionally, chemical treatment such as ozonolysis, oxygen plasma, photolysis and selective dissolution can be used to remove residual organic constituents in order to confer additional porosity on the film." (Emphasis added; column 5, lines 25-28.)

Because the only portions of the organosilicon compound are the non-oxygen and non-silicon portions, the only remaining function is that which is necessarily removed by the oxygen plasma, which **Brinker** indicates is the "organic constituents." This specifically and necessarily means the R or R' ligands which **Brinker** indicates may be "alkyl" of which "methyl" or "-CH_3" is the simplest. (For verification, see Hackh's Chemical Dictionary, page 27.) Ergo, the methyl groups are specifically and **necessarily** removed by the oxygen plasma.

Therefore, the express teaching of each of **Wang**, **Morita**, and **Brinker**, is that O_2 plasma **necessarily** removes at least some of the organic portion (i.e. methyl groups).

6. Claims **102**-112, 115-124, 126-128 and **129**-131, 133, 134 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention.

The specification fails to provide support for the presently claimed combination of (1) using a dry oxygen plasma to deposit the first layer; (2) then converting the whole first layer to a the insulative layer using an oxygen plasma; and (3) without converting the base chemistry, reducing the dielectric constant of the insulative layer using an oxygen plasma. In short, the specification fails to provide support for this specific combination. While it is acknowledged that

in **one group of embodiments** in the specification --presented at p. 6, line 21 to p. 8, line 24-- the first layer is deposited using an oxygen plasma, in these embodiments in which the oxygen plasma is used to deposit the first layer, there exists **no** step for converting the first layer into the insulative layer using an oxygen plasma because oxygen is already incorporated during the deposition of the first layer, as $(CH_3)_XSiO_Y$.

By contrast, in the presently claimed group of embodiments of independent claims 102 and 129, the specification --presented at p. 9, lines 1-24-- indicates that the first layer is deposited by "plasma treatment" --**not** a "dry oxygen comprising gaseous material while generating a plasma in a chamber"-- and then converted to the insulative layer using an oxygen plasma specifically to incorporate oxygen. The specification states at p. 9, lines 1-24,

> "Such describes but **one example process** of forming an interlevel dielectric layer, here by chemical vapor deposition with or without plasma in a chemical vapor deposition chamber [referring to the previous embodiments]. In but **another** considered **example**, a gaseous precursor compound is introduced into a chemical vapor deposition reaction chamber and subjected to **a plasma treatment** [--**not** dry oxygen plasma--]. A semiconductor substrate is provided in the chamber, and **material comprising carbon and silicon** [--**not** carbon, silicon, and oxygen--] is deposited from the plasma-treated precursor compound to over the substrate. **After** the material is deposited, it is exposed to an **oxygen containing moiety** and **converted** to a second material comprising silicon, carbon and **oxygen**." (Emphasis added.)
>
> "In a more specific example, methylsilane is flowed into a reaction chamber at a pressure of from 300 mTorr to about 30 Torr (preferably from about 1 Torr to about 10 Torr) and subjected to a plasma formed at a power of from about 50 watts to about 500 watts (preferably from 100 watts to about 200 watts). A semiconductor substrate is provided in the reaction chamber and maintained at a temperature of about 0 °C to about 600 °C. The **plasma treated methylsilane** deposits a material comprising **methyl groups and silicon** over the substrate. The deposited material is **then** exposed to an oxygen-containing moiety to convert the material to $(CH_3)_XSiO_Y$. Accordingly in this example from the **oxygen exposure**, **a whole of the deposited dielectric layer is**

> **transformed** from one base chemistry (i.e., that comprising a nondescript **combination of methyl groups and silicon**) to another base chemistry (**i.e.**, $(CH_3)_XSiO_Y$) by the **oxygen exposure**." (Emphasis added.)

Importantly, the above excerpted embodiment group is contrasted with the embodiment group presented on p. 6, line 21 through p. 8, wherein $(CH_3)_XSiO_Y$ is **directly deposited using an oxygen plasma** and methyl silane, and therefore **not** converted from one base chemistry to another in a separate step because it is already $(CH_3)_XSiO_Y$.

In summary, there exists **no** support in the specification to use oxygen plasma to deposit the first layer and then to wholly convert the first layer --already having oxygen-- into the insulative layer containing oxygen because it would already have the oxygen present from the deposition step. Accordingly, the specification fails to provide support for the presently claimed **combination** of steps presented in the claims. This is new matter.

The remaining claims are rejected for depending from the above rejected claims.

Separate but similar rejections exist for dependent claims 116 and 117 because they specifically require the first layer to be $(CH_3)_XSiO_Y$.

7. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

8. Claims **102**-112, 115-124, and 126-128 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding independent claims 102 and 129, as presently written the terminology "that allows..." is indefinite for failing to positively recite whether or not the step is actually carried

out. For example, simply because the oxygen-comprising plasma is "**allows** a base chemistry of the whole deposited first layer to remain substantially without transformation..." is not a positive requirement for the transformation of the dielectric constant to fail to occur. Instead it is merely an observation that the oxygen plasma does not perform the transformation, whether or not it occurs.

The claims will be interpreted as best understood and as broadly interpreted, meaning that the steps are not necessarily performed.

The remaining claims are rejected for depending from the above rejected claims.

Claim Rejections - 35 USC § 102

9. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

10. Claims **102**-105, 107, 108, 110-112, 115-121, 124, 126-128 and **129**, 131, 133, 134 are rejected under 35 U.S.C. 102(e) as being anticipated by US 5,593,741 (**Ikeda**).

Ikeda discloses a method of forming low dielectric constant, interlayer dielectric comprising,

loading a substrate **12** including at least partially formed integrated circuitry **110** thereon into a reaction chamber for a plasma enhanced chemical vapor deposition apparatus (Fig. 1; col. 4, line 46);

with the substrate **12** in the reaction chamber, chemically vapor depositing a first layer **122**, having a first dielectric constant and comprising silicon atoms bonded to carbon atoms (col. 4, lines 30-39), over the substrate and on the at least partially formed integrated circuitry by introducing into the reaction chamber a gaseous material precursor (col. 4, lines 30-39) and a dry oxygen-comprising gaseous material (col. 4, lines 40-42) while generating a plasma in the reaction chamber (Figs. 1, 3(A), 3(B); col. 6, lines 9-51); and

after depositing, blanket exposing the first layer **122** to an oxygen comprising plasma that forms the low dielectric constant insulative layer **120** from the first layer **122**, that inherently reduces the first dielectric constant to a second dielectric constant that is the relatively low dielectric constant for the insulative layer allow and that allows a base chemistry of the whole deposited first layer to remain substantially without transformation to another base chemistry **after** the blanket exposing converts the first layer to the insulative layer, and that is shown to not appreciably etch the first layer (Figs. 1, 3(A), 3(B); col. 6, lines 9-51).

(See also Figs. 4(A)-4(E) and the associated text at col. 6, line 52 to col. 7, line 25.) While **Ikeda** does not discuss the dielectric constant of the "film-forming precursor 122", it is held, absent evidence to the contrary that the dielectric constant is reduced upon exposure to the oxygen plasma, by admission of Applicant in the instant specification. (See instant specification, p. 11, line 12, to p. 12, line 14.) **Ikeda** uses the same plasma conditions and materials as

presently claimed. (See Ikeda, col. 4, lines 30-42; col. 5, lines 15-46; and the Examples in cols. 8-14.)

See *In re Swinhart*, 169 USPQ 226,229 (CCPA 1971) (where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on) and *In re Fitzgerald*, 205 USPQ 594 (CCPA 1980) (the burden of proof can be shifted to the applicant to show that subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 USC 102 or obviousness under 35 USC 103).

Note also that in the decision in *Toro Co. v. Deere & Co.*, 69 USPQ2d 1584 (CA FC 2004), at page 1590, last paragraph, it was held that if "one or more embodiments -- whatever the settings of their operational features -- [] necessarily include or result in the subject matter of [the] limitation," then inherent anticipation of the limitation exists.

Regarding claims 103-105, 107, 108, **Ikeda** discloses oxygen and ozone, which are dry, oxygen comprising gases and a methyl silane (col. 4, lines 30-42).

Regarding claim 110, the stability of the dielectric layer is inherently increased for the reasons indicated in by Applicant and **Ikeda** (Ikeda at col. 6, line 9 to col. 7, line 29).

Regarding claim 111, **Ikeda** disclose the blanket exposing occurs within the reaction chamber without removing the substrate from the reaction chamber between chemical vapor depositing and blanket exposing.

Regarding claim 112, **Ikeda** discloses the temperature during exposure must be less than 550 °C, i.e. 200 to 450 °C because aluminum lines are used (col. 5, 15-19).

Regarding claim 115, the carbon atoms are present as methyl groups if a methyl silane is used as the precursor gas, as admitted by Applicant. Note Ikeda uses methyl silane (col. 4, lines 30-42).

Regarding claims 116, 117, and further regarding claim **129**, the first layer inherently comprises $(CH_3)_XSiO_Y$ which inherently remains substantially as $(CH_3)_XSiO_Y$ based upon Applicant's admissions in the specification.

Regarding claims 118-121, **Ikeda** discloses repetitive cycles of from 0.1 to 30 seconds (col. 3, lines 15-17) and uses plural cycles as shown for example in Fig. 7. Accordingly the total exposure time is from 20, 40, 20-100, or at least 100 seconds.

Regarding claims 126-128, and further regarding claims **129**, 133, and 134 the dielectric constant is inherently 10% less or 15% less or between 2.0 and 2.5, because **Ikeda** uses the same method as presently claimed.

Regarding claim 124 and 131, **Ikeda** discloses the insulative layer is an interlevel dielectric (Figs. 4 and 6).

Claim Rejections - 35 USC § 103

11. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

12. Claims **102**-110, 112, 115-124, 126-128 and **129**-131, 133, 134 are rejected under 35 U.S.C. 103(a) as unpatentable over **Yau** et al. (US 6,072,227) in view of **Morita** (JP 63-157443 A).

Regarding claims 102 and 129, **Yau** discloses the substrate **512** (Fig. 8A) having at least partially formed integrated circuitry formed thereon; depositing thereon a low k dielectric layer

510, 518, (which may be a liner layer, cap layer, intermetal dielectric layer, or etch stop layer; [Abstract]) using a PECVD method with precursors of, for example, methylsilane and an oxygen containing gas, such as O_2 or N_2O (col. 5, lines 35-37). Note that the dielectric layer is porous (col. 3, lines 13-29) and has a dielectric constant of less than 3.0 (**Yau**, claim 13) and in one example, a dielectric constant of 2.5 (col. 15, lines 5-18). The layer has from 1% to 50 % carbon from $Si\text{-}CH_3$ bonds. (See also, col. 12, line 41 to col. 13, line 52.)

Yau does not teach plasma treating the dielectric layer with oxygen plasma.

Morita discloses a very similar method to **Yau** comprising forming a low-dielectric-constant material comprising phenyl or alkyl silicon oxide **10** which inherently has a dielectric constant of less than 3.5 over an integrated circuit Fig. 2; blanket exposing the dielectric to oxygen plasma to form and upper surface **11** of silicon oxide which is inherently effective to reduce the dielectric constant. (See Figs. 1-2; page 2, lower two columns.) Note that a whole of the dielectric layer is not converted from one base to another (Applicant's claim 19) and that the $(CH_3)_xSiO_y$ remains as $(CH_3)_xSiO_y$. Moreover, claim 129 only requires the "whole" insulative layer to **comprise** $(CH_3)_XSiO_Y$ which does not require the whole layer to **be** $(CH_3)_XSiO_Y$. Note that the plasma exposure time is 10 minutes.

To quote from **Morita** at page 5,

> "When this semiconductor substrate 1 is exposed to an **oxygen plasma** for ten minutes, the **organic functional groups** of **organic** silicon thin film 10 **are removed** to a desired depth, transforming into a silicon oxide film. As such, the film thickness of organic silicon thin film 10 as initially formed, in its thinnest portions, transforms **nearly** entirely to silicon oxide film 11; only in the thickest portion does it come so as to have **a two-layer structure of silicon oxide film 11 and organic film 10** (figure 3)." (Emphasis added; page 5 of translation, lines 5-14).

Morita teaches that the oxygen plasma treatment solves the problem of poor insulation of the upper portion of organic spin-on glasses by removing the excess organic moieties at the surface, while beneficially preserving adhesion to the underlying layers by leaving the organic moieties in the lower portion of the film. The **Morita** exposure is indicated not to etch but, instead, only removes a portion of the organic material in the surface of the deposited layer. (See translation provided by Applicant, section entitled "FUNCTION" beginning on p. 3.) While it is noted that a 10-minute exposure converts the thinnest portions of the insulative layer to silicon dioxide, the plasma exposure is still "**effective** to allow a base chemistry of the whole deposited first layer to remain substantially without transformation" since (1) no requisite is provided for "substantially;" and (2) since as noted above in the rejection of the claims under 35 USC 112(2), there exists no requirement for this step to even occur in independent claim 102, as it is not positively recited to occur.

Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention to modify **Yau** to carry out the plasma treatment in **Morita** for the reasons just indicated in **Morita** for carrying out the plasma treatment. As indicated the dielectric would inherently be lowered because Applicant indicates that an oxygen plasma treatment will lower the dielectric constant. This makes common sense since the organic portion removed will leave behind additional porosity in the **Yau** dielectric layer, and space has the lowest dielectric constant attainable thereby lowering the overall dielectric constant of the layer.

Regarding claim 103, **Yau** discloses O_2 and N_2O and any oxygen containing gas, as noted above.

Regarding claims 104, 105 as noted above, **Morita** teaches oxygen which is not water and is therefore, dry oxygen.

Regarding claim 106-108, **Yau** discloses nitrous oxide, N_2O.

Regarding claim 109, **Yau** discloses methyl silane and N_2O deposition, and **Yau** teaches oxygen plasma exposure.

Regarding claim 110, the stability of the dielectric layer is inherently increased for the reasons indicated in **Morita** and by Applicant.

Regarding claim 112, **Morita** teaches that the organic silicon film is cured at 450 °C and no heating appears to be indicated; therefore, the temperature during exposure must be less than 550 °C.

Regarding claims 115, 122, 123, and 130, both **Yau** and **Morita** make the film from at least methylsilane. **Yau** specifically indicates that the film has from 1-50% carbon arising from Si-C bonds, preferably 20%. (col. 5, lines 12-44). Furthermore, Applicant has not indicated any criticality to the claimed portions. See In re Hoeschele, 406 F.2d 1403, 160 USPQ 809 (CCPA 1969) (Claimed elastomeric polyurethanes which fell within the broad scope of the references were held to be unpatentable thereover because, among other reasons, there was *no evidence of the criticality* of the claimed ranges of molecular weight or molar proportions.). Any difference is a matter of routine optimization within prior art general conditions. (See MPEP 2144.05.)

Regarding claim 116, **Morita**, as noted above indicates that the exposure the organo dielectric leaves the organo dielectric substantially as its original composition. Since **Yau** teaches Applicant's specific method of deposition using Applicant's claimed methylsilane, the

deposited film is $(CH_3)_XSiO_Y$, which would stay "substantially as $(CH_3)_XSiO_Y$" according to the teachings in **Yau** and by Applicant.

Regarding claims 117-121, although the time is not exactly as claimed by Applicant, it has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. See In re Huang, 40 USPQ2d 1685, 1688(Fed. Cir. 1996). In the instant case, there exists no evidence of record to indicate that some unexpected result arises from the claimed time range relative to that in the applied art. It would have been obvious for one of ordinary skill in the art, at the time of the invention to use a shorter exposure time than in **Morita** since the dielectric layer formed by **Yau** is already porous and oxidized by the method of deposition rather than being a solid mass formed by a spin-on technique. The choice of exact time is an obvious matter of routine optimization to provide the best dielectric layer with the lowest reasonable dielectric constant.

Regarding claim 124 and 131, as noted above, the insulative layer may be an interlayer dielectric.

Regarding claims 126-128, 133, and 134, the **Yau** deposited dielectric layer is deposited with a dielectric constant of 2.5, as noted above. It is held absent evidence to the contrary that the dielectric constant is reduced by at least 10% or about 15% by exposure to the oxygen plasma and that the dielectric constant is inherently stabilized. If it is thought for some reason that the dielectric constant is not reduced or is not stabilized by exposure to the oxygen plasma, then these may be a difference. But, it has been held, where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject

matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on. (See MPEP 2112.) Given the similarity (if not equality) of the dielectric materials formed, the present evidence indicates that the dielectric constant must necessarily be reduced and stabilized.

13. Claim 111 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Yau** in view of **Morita**, as applied to claims **102**-110, 112, 115-124, 126-128 above, and in further view of **Miyasaka** (US 6,017,779).

The prior art as explained above discloses all of the limitations of the claimed invention except for (1) depositing the $(CH_3)_xSiO_y$ layer and exposing in the same chamber is not taught (Applicant's claims 8 and 34); and (2) shutting off the silicon process gas and maintaining conditions in the chamber to expose the dielectric to the oxygen plasma is not taught (Applicant's claim 35).

Miyasaka teaches a method of forming a silicon oxide layer on a semiconductor device using plasma-enhanced CVD with silicon-containing compound and a oxygen-containing gas and then shutting off the silicon-containing precursor and then exposing to the oxygen plasma in the same chamber maintained at sub-atmospheric pressure. (See **Miyasaka**, column 44, "Example 6" especially lines 35-52.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify either of **Yau** in view of **Morita** to maintain a device in a single chamber as taught by **Miyasaka** in order to beneficially prevent contamination to the semiconductor device

dielectric layer between process steps, as is well known in the art to do, and furthermore, because it would simplify the process dramatically by preventing a switch in chambers.

Response to Arguments

14. Applicant's arguments filed 3 May 2004 have been fully considered but they are not persuasive.

Applicant's comments regarding the restriction requirement are addressed above.

Regarding the rejection of the claims under 35 USC 112(1), Applicant argues,

> "In particular Applicant notes that p. 10, lines 12-19 and p. 10, line 22 to page 11, line 5 along with page 12, lines 15-21 clearly enable the bulk of the subject matter set forth in claims 102 and 129. Additionally, page 8, line 16 referring to page 6, line 21 to page 8, line 15, and **perhaps** elsewhere throughout the specification, clearly enable any remaining subject matter set forth in claims 102 and 129."

Examiner disagrees for reasons already of record, as repeated above in the rejection of the claims. Moreover, Applicant's argument is defective for failing to point out how the specification and drawings enable any person skilled in the art to make and use the subject matter defined by each of the rejected claims. It is not sufficient to merely state that it is in the specification because the Office action pointed out why the claims, specification, and drawings are insufficient.

To the extent that Applicant argues the references of Yau and Morita separately, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). In this regard, Applicant argues that "Morita can no longer be considered to disclose every limitation set forth in claim

102." (REMARKS, p. 16, last paragraph.) Examiner agrees. The rejection, however, is over Yau in view of Morita. Morita was never suggested as a singular reference "disclos[ing] every limitation set forth in claim 102." Accordingly, the argument fails to address the rejection presented in the Office action filed 2 February 2004.

Applicant argues that Morita teaches conversion of the base chemistry by the oxygen plasma treatment and therefore does not teach the claimed limitation wherein the "blanket exposing the first layer to an oxygen comprising plasma ... that allows a base chemistry of the whole deposited first layer to remain substantially without transformation to another base chemistry." Examiner respectfully disagrees. Morita discloses this to the same extent as does the instant specification. As noted above in the rejection of the claims under 35 USC 112(1), the instant specification states,

> "It is a preferred intent of the exposing to further not transform **a whole of all** of the dielectric layer from one base chemistry to another base chemistry by the exposing. An **outermost portion of the exposed layer might experience a slight reduction in carbon content**, but otherwise that portion and the whole of the layer is not transformed from one fundamental material to another even in spite of the low k reducing or resulting property." (Emphasis added; page 12, lines 3-9.)

Accordingly the instant specification teaches that the base chemistry is converted to some extent. Morita, similarly states that only the surface is converted --not the whole film. So Morita teaches that the base chemistry of the "whole" layer is substantially untransformed. For at least this reason, Applicant's argument is not persuasive.

Applicant argues regarding claim 129, at p. 18 of the REMARKS,

> "Page 6 of the Office Action states that claim 129 'only requires the 'whole' insulative layer to comprise $(CH_3)_xSiO_y$ which does not require the whole layer to be $(CH_3)_xSiO_y$.' Applicant asserts that the Office's interpretation ignores the literal meaning of the terms sets forth in claim

> 129. The word 'whole' is defined in The American Heritage Dictionary of the English Language, Fourth Edition, published by Houghton Mifflin Company as containing all components, complete, not divided or disjoined, in one' unit, constituting the full amount, etc.
> Applicant notes that reference to different dictionaries reveals equivalent definitions. Also, the present specification uses the term 'whole' in an equivalent manner at least on page 9, line 21, page 12, lines 4 and 7, and page 15, line 2."

While Examiner respectfully submits that Examiner is quite well aware of the definition of the word "whole," Applicant appears to disregard the mean of the word "comprise." The legal meaning of the word "comprise" --not to mention the definition of the word "comprise"-- is "includes," as Applicant should be very well aware. Therefore there exists no requirement for the whole layer to be $(CH_3)_xSiO_y$. Rather the only requirement is that it include $(CH_3)_xSiO_y$, which is the case in each of Yau and Morita.

In this regards, Applicant may benefit from reviewing the following case law on claim construction:

Claim interpretation must begin with the language of the claim itself. See *Smithkline Diagnostics, Inc. v. Helena Laboratories Corp.*, 859 F.2d 878, 882, 8 USPQ2d 1468, 1472 (Fed. Cir. 1988).

First, and most important, the language of the claim defines the scope of the protected invention. *Yale Lock Mfg. Co. v. Greenleaf*, 117 U.S. 554, 559 (1886) ("The scope of letters patent must be limited to the invention covered by the claim, and while the claim may be illustrated it cannot be enlarged by language used in other parts of the specification."); *Autogiro Co. of Am. v. United States*, 384 F.2d 391, 396, 155 USPQ 697, 701 (Ct. Cl. 1967) ("Courts can neither broaden nor narrow the claims to give the patentee something different than what he has set forth [in the claim]."). See also *Continental Paper Bag Co. v. Eastern Paper Bag Co.*, 210 U.S. 405, 419 (1908); *Cimiotti Unhairing Co. v. American Fur Ref. Co.*, 198 U.S. 399, 410 (1905). Accordingly, "resort must be had in the first instance to the words of the claim" and words "will be given their ordinary and accustomed meaning, unless it appears that the inventor used them differently." *Envirotech Corp. v. Al George, Inc.*, 730 F.2d 753, 759, 221 USPQ 473, 477 (Fed. Cir. 1984). Second, it is equally "fundamental that claims are to be construed in the light of the specification and both are to be read with a view to ascertaining the invention" *United States v. Adams*, 383 U.S. 39, 49, 148 USPQ 479, 482 (1966).

The general claim construction principle that limitations found only in the specification of a patent or patent application should not be imported or read into a claim must be followed. See *In re Priest*, 582 F.2d 33, 37, 199 USPQ 11, 15 (CCPA 1978). One must be careful not to confuse impermissible imputing of limitations from the specification into a claim with the proper reference to the specification to determine the meaning of a particular word or phrase recited in a claim. See *E.I. Du Pont de Nemours & Co. v. Phillips Petroleum Co.*, 849 F.2d 1430, 1433, 7 USPQ2d 1129, 1131 (Fed. Cir.), cent. denied, 488 U.S. 986 (1988).

As stated by the court in *In re Hiniker Co.*, 150 F.3d 1362, 1369, 47 USPQ2d -523, 1529 (Fed. Cir. 1998) "[t]he name of the game is the claim." Claims will be given their broadest reasonable interpretation consistent with the specification, and limitations appearing in the specification are not to be read into the claims. *In re Enter*, 756 F.2d 852, 858, 225 USPQ 1, 5 (Fed. Cir. 1985).

Further in this regard, Applicant argues that the word comprise does not meet its own dictionary definition of "includes." Applicant is wrong. Transitional phrases maintain their legal interpretation regardless of where they appear in the claim. Such phrases are commonly used within claims to limit groups of materials such as "selected from the group consisting of..." Examiner invites Applicant to provide a legally binding precedent for such allegation regarding transitional phrases within the body of a claim. Moreover, for reasons indicated in the rejection, **the specification admits to some degree of conversion from one base chemistry to another** of a substantial portion of the insulative layer. Accordingly the argument is not persuasive.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 571-272-1693. The examiner can normally be reached on 9:00 - 19:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Erik Kielin
Primary Examiner
8 June 2004